CLAIMS

1. A method comprising:

providing a macromolecular medium comprising highly conductive threads;
decreasing the viscosity of the macromolecular medium;
processing the macromolecular medium; and
increasing the viscosity of the macromolecular medium;
wherein the viscosity of the macromolecular material is decreased to 100 N.s/m^2 or less;
wherein no more than 50% of the highly conductive threads disintegrate during the duration of time between the decreasing and the increasing.

2. The method of claim 1 wherein the duration is 4 hours or less.

3. The method of claim 1 wherein the decreasing reduces the viscosity of the macromolecular material to 0.1 N.s/m^2 or less.

4. The method of claim 1 wherein no more than 10% of the highly conductive threads disintegrate during the duration of time.

5. A method comprising:

providing a macromolecular medium comprising highly conductive threads;
adding a solvent to the macromolecular medium to form a solution;
processing the macromolecular solution; and
evaporating the solvent from the macromolecular solution;
wherein the macromolecular solution has a viscosity of 100 N.s/m^2 or less;

wherein no more than 50% of the highly conductive threads disintegrate during the dissolving.

6. The method of claim 5 wherein the dissolving comprises mixing the macromolecular medium in the solvent for 15–30 minutes.

7. The method of claim 5 wherein a duration of time between the dissolving and evaporating is 3 hours or less.

8. The method of claim 5 wherein the macromolecular solution has a viscosity of 0.1 $N.s/m^2$ or less.

9. A method comprising:
providing a macromolecular medium comprising highly conductive threads;
depositing a layer of solvent upon a layer of the macromolecular medium;
allowing a portion of the macromolecular material to diffuse into the solvent;
removing the solvent comprising the diffused portion to obtain a retentate of enriched macromolecular material.

10. The method of claim 9 further comprising applying a magnetic field to the layer of the macromolecular medium.

11. A method comprising:
providing a macromolecular medium comprising highly conductive threads;
pulverizing the macromolecular medium to produce a powder comprising particles;

separating the particles using an electromagnetic field into particles containing highly conductive threads and particles containing substantially no highly conductive threads; and

collecting the particles containing highly conductive threads to obtain an enriched conductive powder.

12. The method of claim 11 wherein no more than 50% of the highly conductive threads disintegrate during the pulverizing.

13. The method of claim 11 wherein the electromagnetic field is a static electric field.

14. The method of claim 11 wherein the electromagnetic field is a static magnetic field.

15. The method of claim 11 wherein the pulverizing is performed at a temperature below a glass transition temperature of the macromolecular medium.

16. The method of claim 11 wherein no more than 10% of the highly conductive threads disintegrate during the pulverizing.

17. The method of claim 11 further comprising subjecting the collected particles to an electric field such that the collected particles electrically join to form a highly conductive material.

18. The method of claim 17 wherein the electric field is created using two pointed electrodes.

19. The method of claim 17 wherein the collected particles are heated above a glass transition temperature of the collected particles.

20. The method of claim 11 wherein the macromolecular medium is an enriched medium.

21. The method of claim 11 further comprising heating the collected particles above a glass transition temperature of the macromolecular medium.

22. The method of claim 11 further comprising packing the collected particles into a tube and applying a voltage between ends of the tube.

23. The method of claim 22 wherein the packed particles are heated above a glass transition temperature of the packed particles during the application of the voltage.

24. The method of claim 22 wherein the packed particles are heated during the application of voltage such that the viscosity of the packed particles is 100 $N.s/m^2$ or less.

25. A method comprising:
providing a macromolecular material comprising free electrons;
dissolving the macromolecular material in a solvent to form a lower viscosity medium;
subjecting a portion of the lower viscosity medium to an electromagnetic field so that a concentration of free electrons in the portion of the lower viscosity medium is increased;
collecting the portion of the lower viscosity medium; and

evaporating the solvent from the portion of the lower viscosity medium to obtain an enriched macromolecular material.

26. A method comprising:

providing a macromolecular material comprising free electrons;

fractionating the macromolecular material to produce fractions having differing concentrations of free electrons; and

collecting a first fraction having a highest concentration of free electrons to obtain an enriched macromolecular material.

27. The method of claim 26 wherein the fractionation comprises multiple diffusion paths in a porous medium.

28. The method of claim 26 wherein the fractionating comprises adsorption.

29. The method of claim 26 wherein the fractionating comprises deabsorption.

30. The method of claim 26 further comprising collecting a second fraction having a second-highest concentration of free electrons and combining the first fraction with the second fraction to obtain the enriched macromolecular medium.

31. The method of claim 26 wherein the fractionating comprises subjecting the macromolecular medium to a force causing the medium to flow.

32. The method of claim 31 wherein the force is produced by an electromagnetic field.

33. The method of claim 31 wherein the force is produced by a pressure differential.

34. The method of claim 26 further comprising heating the macromolecular material to reduce its viscosity.

35. The method of claim 26 further comprising adding a solvent to the macromolecular material to reduce its viscosity.

36. The method of claim 26 wherein the fractionating comprises inducing differing flow rates between the fractions using an electromagnetic field.

37. The method of claim 26 further comprising heating the macromolecular material to reduce its viscosity.

38. The method of claim 26 further comprising adding a solvent to the macromolecular material to reduce its viscosity.

39. A method comprising:

providing a macromolecular material comprising free electrons;

dissolving the macromolecular material in a solvent to form a solution;

flowing the solution along a surface of an active solid, wherein an interaction between the active solid and the flowing solution separates the flowing solution into fractions having differing concentrations of free electrons;

collecting a separated fraction of the solution to obtain an enriched macromolecular material.

40. The method of claim 39 wherein the concentration versus time is calibrated, and collection is made at the time of highest concentration.

41. A method comprising:

providing a macromolecular medium comprising free electrons;

separating the macromolecular medium into fractions having differing concentrations of free electrons; and

collecting a first fraction having a highest concentration of free electrons to obtain an enriched macromolecular medium.

42. The method of claim 41 wherein the separating comprises precipitation and the first fraction comprises a precipitate.

43. The method of claim 41 wherein the macromolecular medium contains more than 50 weight % of a solvent.

44. The method of claim 41 wherein the separating comprises adding a second solvent to cause precipitation.

45. The method of claim 41 wherein the separating comprises changing a concentration of the solvent to cause precipitation.

46. The method of claim 41 wherein the separating comprises changing a temperature of the macromolecular medium to cause precipitation.

47. The method of claim 41 wherein the separating comprises changing a pH of the macromolecular medium to cause precipitation.

48. A method comprising:

providing a macromolecular medium comprising free electrons;

inducing the medium to form a precipitate having an increased concentration of free electrons;

subjecting the macromolecular medium to a gravitational force such that the precipitate is separated; and

extracting the precipitate to obtain an enriched macromolecular medium.

49. A method comprising:

providing a macromolecular medium comprising free electrons;

filtering the macromolecular medium to produce a retentate having an increased concentration of free electrons; and

collecting the retentate to obtain an enriched macromolecular medium.

50. The method of claim 49 further comprising lowering the viscosity of the macromolecular medium prior to filtering.

51. The method of claim 50 wherein lowering the viscosity comprises heating the macromolecular medium.

52. The method of claim 50 wherein lowering the viscosity comprises adding a solvent to the macromolecular medium.

53. The method of claim 49 wherein filtering comprises passing the macromolecular medium through a cross-flow filter.

54. The method of claim 49 wherein collecting the retentate comprises back flushing a filter.

55. The method of claim 49 wherein filtering comprises increasing a differential pressure across a filter.

56. The method of claim 55 wherein increasing the differential pressure comprises creating a vacuum.

57. The method of claim 55 wherein increasing the differential pressure comprises employing a centrifuge.

58. The method of claim 49 wherein collecting comprises extracting a filter material and dissolving the filter material using a solvent.

59. The method of claim 58 wherein the filter material is a salt.

60. The method of claim 58 wherein the salt is sodium chloride.

61. The method of claim 58 wherein the salt is compacted.

62. The method of claim 58 wherein the solvent is water.

63. A method comprising:

providing a macromolecular medium comprising highly conductive threads and a remaining macromolecular medium;

separating the highly conductive threads from the remaining medium using a technique based on a density difference between the highly conductive threads and the remaining medium;

forming an enriched macromolecular medium from the separated highly conductive threads.

64. The method of claim 63 wherein the technique comprises centrifuging the macromolecular medium.

65. The method of claim 63 further comprising reducing the viscosity of the macromolecular medium prior to separating.

66. The method of claim 65 wherein reducing the viscosity comprises heating the macromolecular medium.

67. The method of claim 65 wherein reducing the viscosity comprises adding a solvent to the macromolecular medium.

68. The method of claim 63 further comprising lowering the temperature to increase viscosity after the separating.

69. A method comprising:

providing on a conducting substrate a layer of film composed of a macromolecular material comprising at least one conductive channel;

depositing on an exposed surface of the layer of film a second layer of film composed of a macromolecular medium comprising highly conductive threads;

coupling an electrode to an exposed surface of the deposited second layer of film;

applying a voltage between the electrode and the conducting substrate until a predetermined level of current flows; and

decoupling the electrode from the exposed surface of the deposited second layer of film.

70. The method of claim 69 wherein the conducting substrate comprises a metal conductor.

71. The method of claim 69 further comprising evaporating a solvent from the deposited second layer of film.

72. The method of claim 69 further comprising evaporating a solvent from the deposited second layer of film.

73. The method of claim 69 wherein the predetermined level of current is greater than 1 mA.

74. The method of claim 69 wherein the macromolecular medium is an enriched macromolecular medium.

75. The method of claim 69 wherein the macromolecular medium has a viscosity of 100 N.s/m^2 or less.

76. The method of claim 69 wherein the macromolecular medium comprises a dopant.

77. The method of claim 69 further comprising exposing the second layer of film to a magnetic field for at least a part of the duration of the application of the voltage between the electrode and the conducting substrate.

78. A method comprising:

providing a macromolecular medium comprising free electrons;

providing a first highly conductive macromolecular material;
providing a second highly conductive macromolecular material;
placing a portion of the macromolecular medium between the first highly conductive material and the second highly conductive material; and
applying a voltage between the first highly conductive material and the second highly conductive material until a predetermined level of current flows to form a conjoined highly conductive macromolecular material.

79. The method of claim 78 further comprising evaporating a solvent from the portion of the macromolecular medium.

80. A method comprising:
providing a macromolecular medium comprising free electrons;
providing a first highly conductive material;
providing a second highly conductive material;
placing a portion of the macromolecular medium between the first highly conductive material and the second highly conductive material; and
applying a voltage between the first highly conductive material and the second highly conductive material until a predetermined level of current flows to form a conjoined highly conductive material.

81. The method of claim 80 further comprising evaporating a solvent from the portion of the macromolecular medium.

82. The method of claim 80 wherein the first or second highly conductive materials is a superconductor.

83. The method of claim 80 wherein the first or second highly conductive materials is a carbon nanotube.

84. The method of claim 80 wherein the first or second highly conductive materials is a one-dimensional conductor.

85. A method comprising:

providing a macromolecular medium comprising free electrons;

providing a first electrode and a second electrode such that the first electrode and second electrode are separated by a non-zero distance;

depositing a portion of macromolecular medium between the first electrode and the second electrode;

applying a voltage between the first and second electrodes until a current flows;

increasing the non-zero distance between the first electrode and the second electrode; and

applying a second voltage between the first and second electrodes until a current flows, thereby producing a highly conductive thread within the portion of macromolecular medium.

86. The method of claim 85 further comprising maintaining the first electrode and second electrode in physical contact with the deposited portion of macromolecular medium.

87. The method of claim 85 further comprising evaporating a solvent from the deposited portion of macromolecular medium.

88. The method of claim 85 wherein the current is at least 1 mA.

89. The method of claim 85 further comprising decreasing the non-zero distance between the first electrode and the second electrode if a current does not flow after a predetermined period of time.

90. The method of claim 85 wherein the first electrode has a pointed tip with a radius of curvature less than 1 micron.

91. The method of claim 85 wherein the second electrode has a pointed tip with a radius of curvature less than 1 micron.

92. The method of claim 85 wherein the macromolecular medium has a viscosity of 100 $N.s/m^2$ or less.

93. The method of claim 85 wherein the macromolecular medium comprises a dopant.

94. The method of claim 85 wherein the macromolecular medium is reduced in viscosity.

95. The method of claim 85 further comprising adding a second portion of macromolecular medium to the deposited portion, thereby allowing a length of the produced highly conductive thread to be increased.

96. The method of claim 85 wherein the first electrode and second electrode are highly conductive macromolecular materials.

97. The method of claim 85 further comprising enriching the macromolecular medium.

98. The method of claim 85 wherein the macromolecular medium has a viscosity of 100 $N.s/m^2$ or less.

99. The method of claim 85 wherein the non-zero distance is initially less than 100 microns.

100. The method of claim 85 wherein increasing the non-zero distance withdraws a portion of the produced highly conductive thread out of the deposited portion of macromolecular medium.

101. The method of claim 100 further comprising increasing the viscosity of the withdrawn portion of macromolecular medium.

102. The method of claim 101 wherein increasing the viscosity comprises evaporating a solvent.

103. The method of claim 101 wherein increasing the viscosity comprises cooling.

104. The method of claim 101 wherein increasing the viscosity comprises inducing crosslinking.

105. The method of claim 85 further comprising adding a portion of enriched macromolecular medium to the deposited portion.

106. The method of claim 85 wherein the first electrode and second electrode are resistant to decomposition by the deposited macromolecular medium.

107. The method of claim 85 wherein the first electrode and second electrode are cross-linked highly conductive macromolecular materials.

108. A macromolecular material comprising a conductive thread longer than 500 microns with conductivity greater than 10^6 S/cm.

109. A method comprising:
providing an enriched macromolecular medium comprising free electrons;
producing a macromolecular material from the enriched macromolecular medium;
wherein the produced macromolecular material has a diamagnetism exceeding $-1.0*10^{-5}$ CGS units;
wherein the yield of the produced macromolecular material is at least 10%

110. A method comprising:
providing an enriched macromolecular medium comprising free electrons;
producing a macromolecular material from the enriched macromolecular medium;
wherein the produced macromolecular material has a diamagnetism exceeding $-10.0*10^{-5}$ CGS units;
wherein the yield of the produced macromolecular material is at least 1%.

111. A device comprising a macromolecular material with diamagnetism exceeding $-1.0*10^{-5}$ CGS units.

112. A device comprising a macromolecular material with diamagnetism exceeding $-10.0*10^{-5}$ CGS units.

113. The device of claim 112 wherein the material is responsive to a magnetic field.

114. The device of claim 112 wherein the material alters a magnetic field.

115. The device of claim 112 wherein the material levitates in response to an external magnetic field.

116. The device of claim 112 wherein the material partially shields portions of the device from an external magnetic field.

117. The device of claim 112 wherein the device produces an output responsive to an external magnetic field.

118. A method comprising:
providing a macromolecular material with diamagnetism exceeding $-1.0*10^{-5}$ CGS units;
solidifying the macromolecular material such that the diamagnetism of the material is preserved in the presence of magnetic fields up to at least 1000 oersted.

119. The method of claim 118 wherein the solidifying comprises cooling the macromolecular material below a glass transition temperature.

120. The method of claim 118 wherein the solidifying comprises cross-linking the macromolecular material.

121. The method of claim 120 wherein the cross-linking is performed in a magnetic field.

122. The method of claim 118 wherein the solidifying comprises adding microscopic particles to the macromolecular material.

123. The method of claim 118 wherein the solidifying comprises attaching the macromolecular material to a solid surface.

124. The method of claim 118 wherein the solidifying comprises encapsulating the macromolecular material in a solid substance.

125. A method comprising:

providing a doped macromolecular medium comprising free electrons;

producing a macromolecular material from the doped macromolecular medium;

wherein the produced macromolecular material has a diamagnetism exceeding $-1.0*10^{-5}$ CGS units;

wherein the yield of the produced highly conductive macromolecular material is at least 1%

126. A method comprising:

providing a macromolecular medium;

ionizing portions of the macromolecular medium to facilitate the creation of free electrons in the macromolecular medium;

collecting the ionized portions to form a macromolecular material comprising free electrons.

127. The method of claim 126 wherein the ionizing comprises spraying drops of the macromolecular medium.

128. The method of claim 127 wherein the spraying comprises applying an electromagnetic field.

129. A method comprising:

providing a macromolecular medium;

providing an ionized gas; and

combining the ionized gas with the macromolecular medium to facilitate the creation of free electrons in the macromolecular medium, thereby producing a macromolecular material comprising an increased number of free electrons.

130. The method of claim 129 wherein providing the ionized gas comprises exposing a gas to a high intensity electric field, thereby ionizing the gas.

131. The method of claim 130 wherein the high intensity electric field is greater than 30 kilovolts/cm.

132. A method comprising:

providing a macromolecular medium;

providing ions; and

implanting the ions within the macromolecular medium to facilitate the creation of free electrons in the macromolecular medium, thereby producing a macromolecular material comprising an increased number of free electrons.

133. The method of claim 132 wherein providing the ions comprises forming the ions using electrolysis.

134. The method of claim 132 wherein providing the ions comprises ionizing a gas;

135. The method of claim 132 wherein implanting the ions comprises directing the ions into the macromolecular medium with an electric field.

136. The method of claim 132 wherein implanting the ions comprises:
lowering a viscosity of the macromolecular medium; and
passing the macromolecular medium through a gas of the ions.

137. The method of claim 136 wherein passing the macromolecular medium through a gas of the ions comprises forming drops of the macromolecular medium, and wherein implanting the ions further comprises collecting the drops.

138. The method of claim 132 wherein providing the ions comprises:
generating the ions through a triboelectric interaction between the macromolecular medium and a second material.

139. The method of claim 132 further comprising lowering the viscosity of the macromolecular medium.

140. A method comprising:
providing a macromolecular medium;
providing a source of electrons; and
implanting electrons from the source of electrons within the macromolecular medium to facilitate the creation of free electrons in the macromolecular medium.

141. The method of claim 140 wherein the implanting is facilitated by an electric field.

142. The method of claim 140 wherein the source comprises a scanning electron microscope.

143. The method of claim 140 wherein the source comprises a cathode.

144. The method of claim 140 wherein the source comprises a field emission device.

145. A method comprising:
providing a macromolecular material; and
implanting electrons in the macromolecular material in accordance with a predetermined pattern, thereby producing a patterned macromolecular material comprising a patterned distribution of free electrons.

146. The method of claim 145 wherein the implanting comprises directing an electron beam toward the macromolecular material.

147. A method comprising:
providing a macromolecular material; and
creating free electrons in the macromolecular material in accordance with a predetermined pattern, thereby producing a patterned macromolecular material comprising a patterned distribution of free electrons.

148. The method of claim 147 wherein the creating comprises directing a laser beam toward the macromolecular material.

149. A method comprising:
providing a macromolecular material;

depositing the macromolecular material on a substrate; and

electrically charging a portion of the substrate such that free electrons are generated in the deposited macromolecular material.

150. The method of claim 149 wherein the charging comprises imposing a voltage for at least 1 hour after the depositing.

151. The method of claim 150 wherein the voltage exceeds 5000 volts.

152. The method of claim 149 wherein the substrate is conductive, and wherein the charging comprises imposing a voltage from a voltage source.

153. The method of claim 149 wherein the charging comprises exposing the substrate to positive or negative ions.

154. The method of claim 149 wherein the charging comprises exposing the substrate to electrons.

155. The method of claim 149 wherein the charging comprises exposing the substrate to a charged material.

156. The method of claim 149 wherein the substrate is a dielectric, and wherein the charging comprises creating a large electrical potential in proximity to the substrate.

157. The method of claim 149 wherein the charging comprises temporarily contacting the substrate with a second material.

158. The method of claim 157 wherein the contacting comprises triboelectric interaction.

159. The method of claim 157 wherein the substrate is glass and the second material is paper.

160. The method of claim 157 wherein the substrate is glass and the second material isa fluorocarbon resin

161. The method of claim 149 further comprising exposing the macromolecular material to ultraviolet light.

162. The method of claim 149 further comprising exposing the macromolecular material to laser light.

163. The method of claim 162 wherein the laser light has a frequency at or above ultraviolet frequency.

164. The method of claim 162 wherein the laser light is tuned to produce a two-photon ionization in the macromolecular material.

165. A method comprising:
providing a macromolecular medium;
irradiating the macromolecular medium with laser light such that free electrons are formed in the macromolecular material, thereby producing a macromolecular material with increased concentration of free electrons.

166. The method of claim 165 wherein the laser light has a frequency at or above ultraviolet frequency.

167. The method of claim 165 wherein the laser light is tuned to produce a two-photon ionization in the macromolecular material.

168. A material composition comprising: a macromolecular material and a dopant, wherein the material has a conductivity of 10^6 S/cm or greater.

169. A method comprising:

providing a macromolecular material;

adding a dopant to the macromolecular material to produce a doped macromolecular material;

generating ions in the doped macromolecular material, thereby producing free electrons in the doped macromolecular material.

170. The method of claim 169 wherein adding the dopant comprises electrolysis.

171. The method of claim 169 wherein the dopant is a material having an ionization potential below 6.95 eV.

172. The method of claim 169 wherein the dopant is a material having an ionization potential below 5.4 eV.

173. The method of claim 169 wherein the dopant is a material selected from the group consisting of elements, inorganic molecules and radicals, and organic and element-organic compounds.

174. The method of claim 169 wherein the dopant is material selected from the class of 3d and 4f transition metals.

175. The method of claim 169 wherein generating ions comprises exposing the macromolecular material to radiation.

176. The method of claim 169 wherein the dopant is an organic salt.

177. The method of claim 169 further comprising cross-linking the ionized, doped macromolecular material.

178. A method comprising:

providing a macromolecular material;

adding a first dopant to the macromolecular material to produce a doped macromolecular material;

adding a second dopant to the doped macromolecular material to produce a doubly-doped macromolecular material, wherein the second dopant reacts with the first dopant to create free radicals; and

inducing the production of free electrons in the doubly-doped macromolecular material.

179. The method of claim 178 wherein adding the first dopant comprises performing electrolysis. wherein the inducing comprises exposing the doubly-doped macromolecular material to radiation.

180. The method of claim 178 wherein adding the second dopant comprises performing electrolysis. wherein the inducing comprises exposing the doubly-doped macromolecular material to radiation.

181. A method comprising:
providing a macromolecular material;
adding a dopant to the macromolecular material to produce a doped macromolecular material, wherein the dopant reacts with the macromolecular material to create free radicals; and
inducing the production of free electrons in the doped macromolecular material.

182. The method of claim 181 wherein the created free radicals are in side chains of macromolecules of the macromolecular material.

183. The method of claim 181 wherein adding the dopant comprises electrolysis.

184. The method of claim 181 wherein the inducing comprises exposing the doped macromolecular material to radiation.

185. The method of claim 184 wherein the radiation is UV radiation.

186. A method comprising:
providing a macromolecular material;
placing an electrolyte in contact with the macromolecular material;

exposing the electrolyte and the macromolecular material to an electromagnetic field to induce ions from the electrolyte to diffuse into the macromolecular material;

inducing the formation of free electrons in the macromolecular material.

187. The method of claim 186 wherein the electrolyte is a salt solution.

188. The method of claim 186 wherein the electrolyte is a gel or a paste.

189. A device comprising a doped macromolecular material having a conductivity greater than 10^6 S/cm.

190. The device of claim 189 wherein the macromolecular material is an enriched macromolecular material.

191. The device of claim 189 wherein the dopant is a material having an ionization potential below 6.95 eV.

192. The device of claim 189 wherein the dopant is a material having an ionization potential below 5.4 eV.

193. The device of claim 189 wherein the dopant is a material selected from the group consisting of inorganic molecules and radicals.

194. The device of claim 189 wherein the dopant is a material selected from the class of organic and element-organic compounds having ionization potentials below 6.95 eV.

195. The device of claim 189 wherein the dopant is a material selected from the class of 3d and 4f transition metals.